Space Weather Technical Forecast

Issued on Sunday, 09 January 2022 at 12:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing Slight Chance of M-class flares (R1-R2 radio blackouts). Increasing Chance of Active fluence

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low over the past 24 hours, with only very minor flares. There are currently four sunspots on the visible disc. The most notable is AR2924, which has shown some slight increase in magnetic complexity and is now classified Ehi/Beta-gamma. The other three spots are all small and simple, although AR2927 near the southeast limb is still foreshortened making classification a little uncertain. There is an area of plage which has rotated onto the northeast limb which shows a fair amount of magnetic flux, but no spots at present, and will be monitored. No confirmed Earth-directed CMEs have been observed in currently available imagery. A prominence liftoff near the southwest limb has yet to be analysed, although this is currently considered unlikely to be Earth-directed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, showed the onset of a CIR (Co-rotating Interacting Region), which preceded entry into the expected high speed stream (HSS) from coronal hole 43. Solar wind speeds were steady at around 300km/s, before rising steadily from 08/1700 UTC to reach elevated levels around 530 km/s. Density was above average for much of the period, with a peak near 50ppcc around 08/1900 UTC, before a gradual decline with the onset of the HSS. The IMF was weak to start, becoming moderate to strong from 08/1700 UTC, before declining back to weak levels after 09/0700 UTC. The Bz was weakly southward directed to start, then varied between +18/-16 nT, before becoming nearer neutral after 09/0700 UTC. Phi angle started positive (away from the Sun), but switched to negative (towards the Sun) from 08/2015UTC. Geomagnetic activity was Quiet to start, becoming Unsettled to Active with a G1/Minor Storm (Kp5) observed in the 21-00UTC interval, before becoming Quiet again from 09/0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels throughout. High energy electron flux (greater than 2MeV) was at High levels, peaking at 2660pfu at 08/1805UTC, before a sharp drop to background levels occurred at 08/2010 UTC due to the CIR ahead of the HSS from CH43. Electron fluence remained below the Active threshold (1e8 integrated pfu) on a fairly steady trend, with 5.87e7 integrated pfu recorded at 09/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low or Very Low, with further C-class flares possible. In addition, there is an increasing daily Slight Chance of M-class flares, as several returning regions are expected to rotate onto the visible disc over the coming days.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs in the forecast. We currently have elevated wind speeds from CH43/-, which are expected to slowly ease through Day 2 into Day 3 (10-11 Jan). Geomagnetic activity is likely to be Quiet to Unsettled, with a chance of Active intervals through Day 1 (09 Jan) and into Day 2. The likelihood of further G1/Minor Storm intervals is now considered very low. Activity is then expected to be mainly Quiet through Days 3 and 4 (11-12 Jan).

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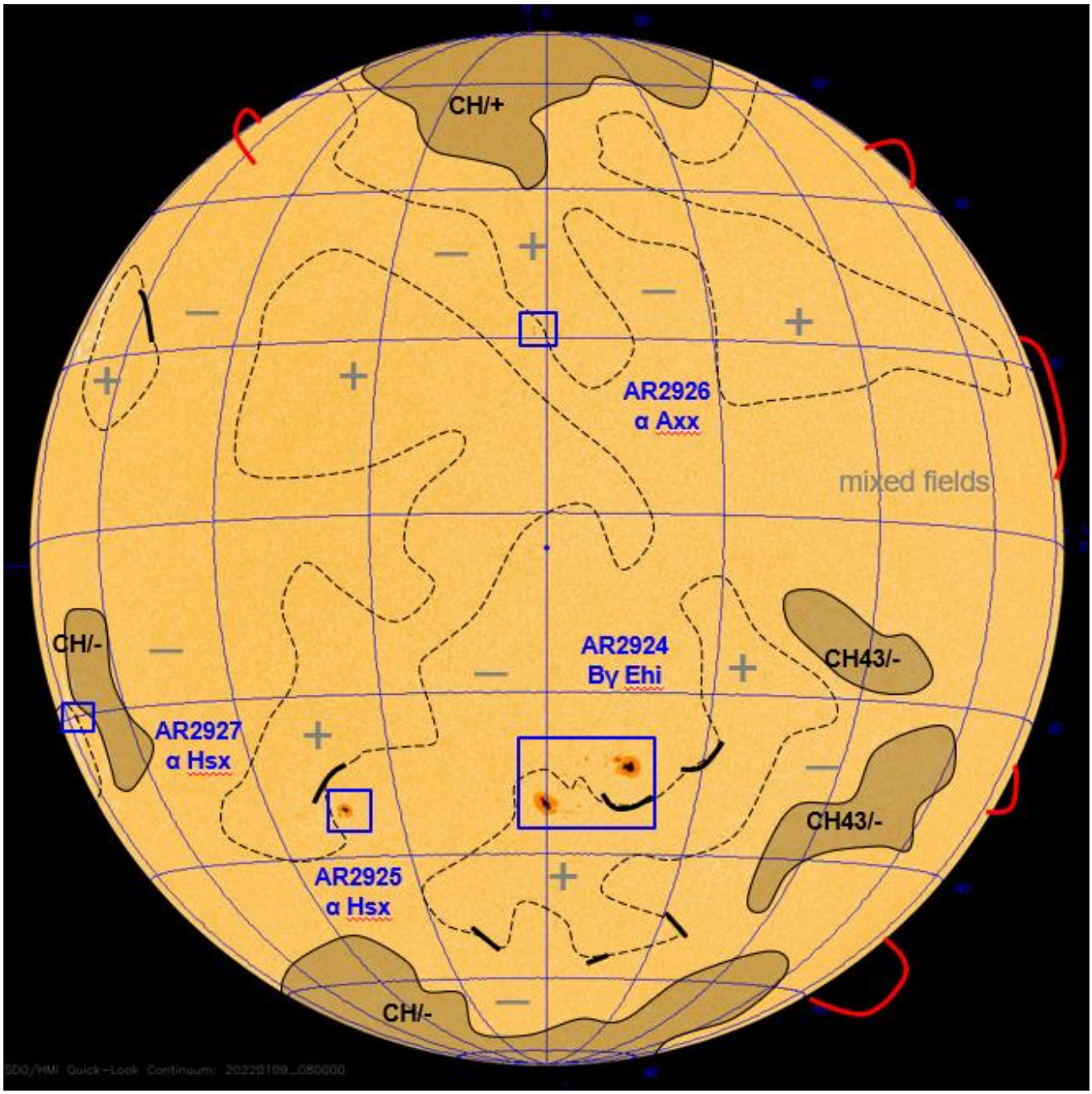
Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, albeit with a very slight increase in risk with the westward progression of the current front-sided sunspots.
The high energy electron flux (greater than 2MeV) is likely to increase through this period as the HSS from CH43 wanes. There is a Chance of Active fluence later in the four-day period after the initial suppression eases.

Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

No Earth-directed CMEs feature in this forecast period. A prominence liftoff near the southwest limb has yet to be analysed, although this is currently considered unlikely to be Earth-directed. The main feature of interest in this period is the non-recurrent coronal hole 43 in the southern solar hemisphere. Earth has experienced the CIR associated with this feature yesterday evening, and we are now in the HSS with elevated wind speeds. It seems likely that wind speeds will remain elevated through the next 24 hours or so, before a gradual easing back to ambient levels later Day 2 into Day 3 (10-11 Jan).

Geomagnetic activity is likely to be Quiet to Unsettled, with a chance of Active intervals through Day 1 (09 Jan) and into Day 2. The IMF, Bt, has already eased back to weak levels after the CIR and as such the likelihood of further G1/Minor Storm intervals is now considered very low. Activity is then expected to be mainly Quiet through Days 3 and 4 (11-12 Jan).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	5	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

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Figure 2: Solar wind data from DSCOVR at L1 showing the recent CIR and HSS onset.

Radio Blackouts - X-Ray Flares:

Solar activity has remained Very Low in the last 24 hours. AR2924 is the most complex spot on the disc, and given this spot's complexity, the current lack of flaring is somewhat below expectations. However, there is some compensation expected as a result of several returning regions over the eastern solar horizon. Newly numbered AR2927 on the southeast limb is likely to be one of two returning regions Ex-2907 and 2908, both M-class flare-producing regions on previous rotation. However, it currently appears to be a small and simple region with little activity. There is also an area of plage rotating onto the northeast limb, this may be Ex-2911, which also gave an isolated M-class flare on its last outing. This area will be monitored for any development. The current lack of flaring and simplicity of the two new regions means the x-ray flare risk has been reduced to 10% at the start of the period.

We are now starting to see numerous CMEs in coronagraph imagery from well over the eastern limb, likely associated with other previous active regions as they rotate around the far side. As such, the expected course of X-ray flux is upwards through the course of next week. The degree to which this occurs is uncertain, however a gradual slight increase in the risk of M-class flares is suggested until they present for analysis and more detail can be given.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	15	20
Very Active	R3 to R5 X Class	No	1	1	1	2

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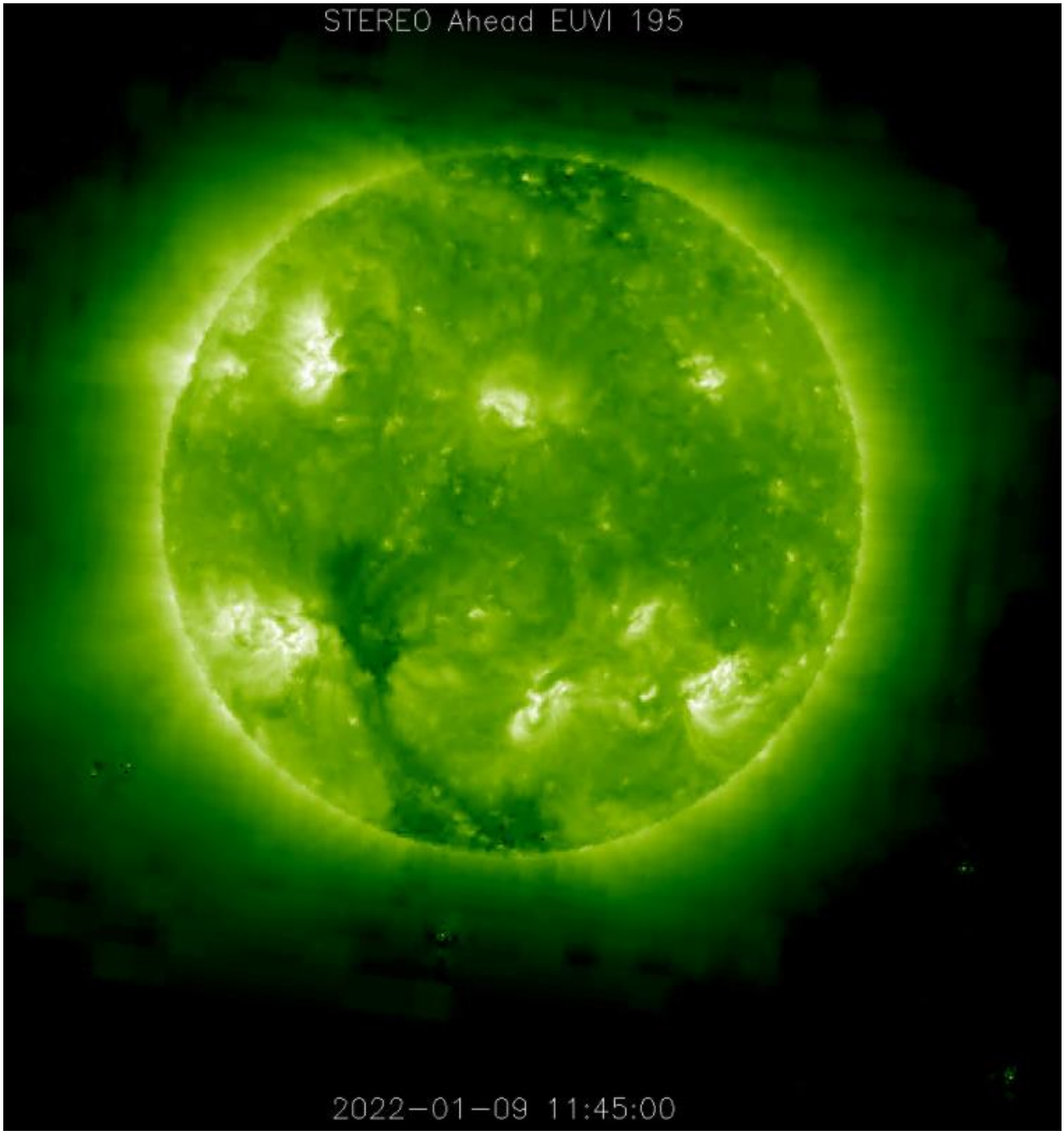
Figure 3: STEREO-A EUVI-195 imagery showing further likely active regions to rotate onto the disc.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at Background levels and will most likely persist at this level in the absence of solar activity. There is just a very slightly increasing chance of S1 as a result of westward progression of the current front sided sunspot groups.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 showed a diurnal peak yesterday above the High threshold, but the arrival of a CIR ahead of the high speed stream (HSS) from CH43/- has sharply suppressed flux levels at GEO back to Normal Background levels. This is likely to continue through Day 1 (09 Jan), then as the HSS wanes and the radiation belts de-compress, a rise is possible from Day 2 (10 Jan) onwards. However, the level of charging likely to occur during this HSS is not certain - due to CH43 being a novel feature with no data from previous rotations to give confidence to the forecast. As such, peaks above the High threshold are certainly possible from Day 2 onwards.
The electron fluence will start below the Active level (1e8 integrated pfu) on a declining trend. Then an increase is likely from Day 2 onwards, with a chance of reaching Active later in the period. Modelling available to MOSWOC is not felt likely to be particularly representative in the current set-up, given the non-persistent coronal hole that dominates the geomagnetic forecast. That said, REFM is starting to show a rising trend, suggesting it is now assimilating the current elevated wind speeds. This means the REFM forecast is likely to start showing a better trend over the next 24 hours.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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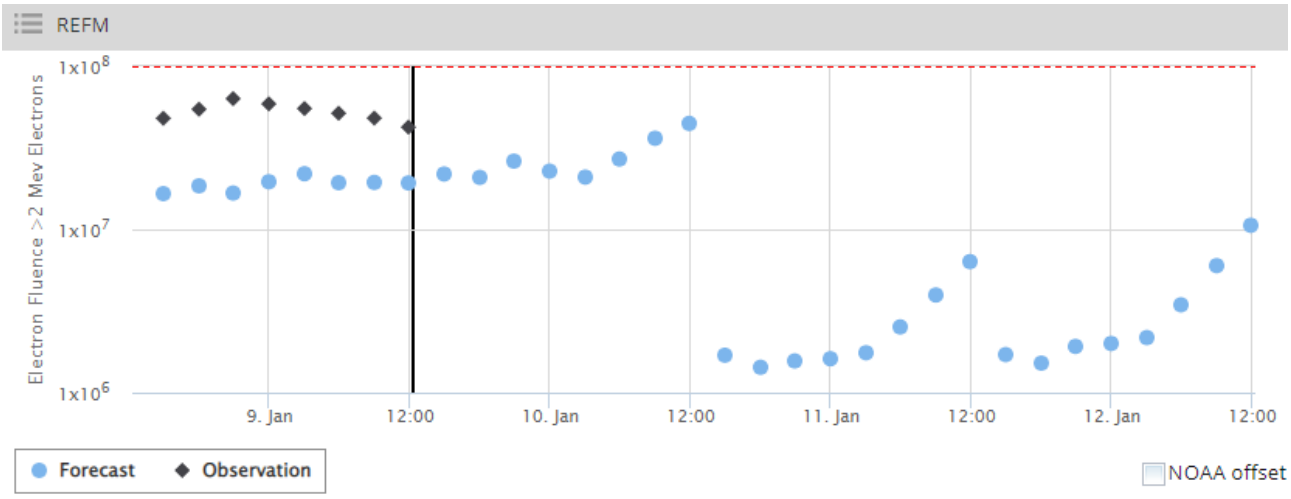
Figure 4: REFM model starting to show an upward trend in fluence levels as it assimilates the increased wind speeds.



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